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(71) Applicant and
(72) Inventor: FORSMAN, Tom [FI/FI]; Nylandsgatan 10 A 24, FIN-20500 Åbo (FI).

(74) Agent: TURUN PATENTTITOIMISTO OY; P.O. Box 99, FIN-20521 Turku (FI).

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(54) Title: A METHOD FOR THE CONTROL OF A GROUND WOOD PULPING PROCESS

(57) Abstract: The invention relates to a method for the control of a ground wood pulping process, whereby pulpwood logs are pressed against the periphery of a rotating grinding stone, the grinding stone is sprayed with water, and the generated fibre suspension, the pulp, is stored, and whereby the pulp's drainability or freeness CF and a second quantity Q characterising the quality of the pulp are measured, the measured values CFx and Qx are compared with the set points CF0 and Q0 of the corresponding quantities, and the wood supply rate Vn or the wood supply pressure Fn and the peripheral speed Vp of the grinding stone are adjusted so that the sum (CFx - CF0)2 + (Qx - Q0)2 obtains its minimum value. Pressurised water sharpening of the grinding stone is initiated when the grinding stone reaches a certain degree of bluntness being defined e.g. as a certain value of the wood supply pressure Fn or the wood supply rate Vn or a variable depending on these, and this pressurised water sharpening is continued until the measured quality quantity Qx deviates from its set point Q0 by a given amount, the difference ΔQ, after which the pressurised water sharpening is discontinued. Then the wood supply rate Vn or the wood supply pressure Fn and the grinding stone's peripheral speed Vp are adjusted so that the sum (CFx - CF0)2 + (Qx - Q0)2 obtains its minimum value.

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A method for the control of a ground wood pulping process

The present invention is based on a previously patented method for the control of a ground wood pulping process in order to achieve an optimal value for both the drainability of the pulp and for another characteristic of the pulp, preferably the tearing resistance of the pulp, and which process uses wood supply rate or wood supply pressure and peripheral speed of the grinding stone as control variables.

The Finnish patent 102975 describes a method for the control of a ground wood pulping process. According to the invention one measures the drainability of the pulp (freeness, CF) and another quantity Q characterising the quality of the pulp, preferably the tearing resistance (tear index RI), and the measured values CFx and Qx are compared with the set points CF0 and Q0 of the corresponding quantities. The wood supply rate Vn or the wood supply pressure Fn and the peripheral speed Vp of the grinding stone are adjusted so that the sum (CFx - CF0)2 + (Qx - Q0)2 obtains its minimum value. The method is based on previously performed tests where it has been found that, at a constant freeness, it is possible to improve the strength properties, particularly the tearing resistance, by reducing the peripheral speed of the grinding stone. According to an article by Jan-Anders Fagerhed, "Development of wood grinding" in Paperi ja Puu - Paper and Timber 72 (1990):7 the tearing resistance of the pulp increases by about 40 % at a grinding overpressure of 0 to 1 bar when the peripheral speed of the grinding stone is reduced from 30 m/s to 10 m/s. The corresponding increase in tearing resistance is about 20 % at an overpressure of 2 bar, and about 8 % at an overpressure of 3 to 4 bar. The same article also discloses that the tensile strength (at a given freeness value) can be affected to a certain extent by the peripheral speed of the grinding stone, though the effect is not as obvious as concerning the tearing resistance. However, an increase of about 35 % in tensile strength is obtained when the grinding is done at atmospheric pressure and the peripheral speed is reduced from 30 m/s to 10 m/s.

The above-mentioned patent publication does not mention sharpening of the grinding stone.

Sharpening becomes necessary when a grinding stone for a ground wood pulping process becomes blunt. Traditionally the grinding stones have been sharpened mechanically. However, some disadvantages are connected with this sharpening method. Firstly, the production must be stopped for the time of the sharpening. Secondly, the stone easily becomes too sharp, which in turn results in too high a freeness of the pulp, and the pulp quality becomes inferior, if the wood supply rate or pressure is not reduced at the same time (i.e., if the production is not reduced). This is due to the fact that a very sharp stone surface will not defibrate the wood in a desired way, but rather cuts out wood particles. In order to compensate for this effect the load must be reduced.

Pressurised water sharpening of grinding stones for ground wood pulping has been proposed in the articles S Blomqvist et al., "Water Jet - New Technique for Pulpstone Surface Control", 1994 Pulping Conference, TAPPI Proceedings, p. 601-610, and A Puurunen et al., "First Mill Scale Experiences of the Water Jet Pulpstone Conditioning System at UPM-Kymmene Voikkaa and Rauma Paper Mill", 1997 Pulping Conference, TAPPI Proceedings, p. 317-322. It was stated that pressurised water at a pressure in the interval 500-2500 bar is suitable for sharpening the grinding stone during operation. It is possible to maintain a higher production and more even drainability and strength properties of the pulp due to the fact that the sharpness of the stone can be controlled very accurately with this sharpening method. The article JHJ Lehto et al., "New Thinking in Ground wood Process Control" (being printed) proposes to automate the sharpening of the grinding stone in a ground wood pulping process. As a measure of the condition of the grinding stone the article's authors introduced the concept "saturation degree", which was defined as the relative time during which the hydraulic valves are open more than 90 %.

None of the above mentioned articles gives any hint about that the sharpening of the grinding stone could be connected to a two-variable control of the ground wood pulping process according to the Finnish patent FI 102975, in which the pulp freeness CF and the quality characteristic Q are used as measurement variables, and the wood supply rate (or the wood supply pressure) and the peripheral speed of the stone are used as control variables. The object of the present invention is to combine the method according to FI 102975 with an automated pressurised water sharpening of the grinding stone, whereby one obtains a three-variable control where the water pressure is the third control variable.

The characteristics of the invention appear in claim 1.

The method can be used both in conventional stone grinding without overpressure (so called stone ground wood or SGW pulp) and in so called pressure grinding (pressure ground wood or PGW).

The CF number and the tear index of the pulp are kept on a desired level, and one minimises the sum of the deviations

$$(CFx - CF0)2 + (RIx - RI0)2$$

where: CF0= freeness set point; CFx = measured freeness value; RI0 = tear index set point; and RIx = measured tear index value.

As examples of the quality characteristics one can mention the delamination strength and bulk.

The relation between the sharpness of the grinding stone and the characteristics of the pulp has previously been published (see e.g. Georg v. Alftan, "Valmistusolojen vaikutus mekaanisen massan ominaisuuksiin", in the textbook "Puukemia", Waldemar Jensen, Helsinki 1967).

FI 102975 presents measurement data which was published by Jan-Anders Fagerhed (Development of wood grinding, Part 3, Effects of casing pressure and pulpstone speed, Paper-Puu - Paper and Timber 72 (1990):7, 680-686), and which was supplemented by up to now unpublished material. With the aid of regression analysis one can determine on the basis of this measurement data the relation between quantities that describe the characteristics of the pulp (freeness, tear index) and the operating conditions of the process.

The grinding process according to this invention is in principle affected by three control variables, that is the wood supply rate (or force), the peripheral speed of the grinding stone, and the water pressure. The supply rate can keep the CF number of the pulp at desired level, and the stone's peripheral speed, another variable, at a desired level. The pressurised water sharpening is started at a certain grinding stone surface condition, i.e. when a certain degree of bluntness is reached. Then this pressurised water sharpening is continued until a quality quantity Qx, advantageously the tear index RI, deviates from its set point Q0 by a given amount, the difference ΔQ, after which the pressurised water sharpening is discontinued, and the wood supply rate Vn or the wood supply pressure Fn and the grinding stone's peripheral speed Vp are adjusted so that the sum $(CFx - CF0)2 + (Qx - Q0)2$ obtains its minimum value.

The degree of bluntness of the grinding stone can be defined in many ways, e.g. as a certain value for the wood supply pressure Fn or the wood supply rate Vn, or for any variable which depends on these. A suitable measure for the bluntness is for instance the relative time that the hydraulic valve (or valves) is open 90 % or more.

The observed quality quantity Q is preferably a measure of the tearing resistance of the pulp, e.g. the tear index RI. In this case the pressurised water sharpening is discontinued when the measured tear index RIx becomes smaller than its set point RI0 by a defined difference ΔRI. Thus the choice of RI0 and ΔRI defines the

desired sharpness of the grinding stone.

Even if it is conceivable to carry out the pressurised water sharpening with a constant water pressure in the interval 500-2500 bar, it is advantageous to successively increase the water pressure during the sharpening. The initial pressure can be about 500 to 1000 bar, and the final pressure about 2500 bar.

During the pressurised water sharpening the wood supply rate Vn, the wood supply pressure Fn and the grinding stone's peripheral speed Vp are kept at least almost constant.

Thus the process can be controlled by a multi-variable method with three input signals and two output signals.

The control can be carried out with the aid of a multi-variable control algorithm that was described in FI 102975.

Claims

1. A method for the control of a ground wood pulping process, whereby pulp wood logs are pressed against the periphery of a rotating grinding stone, the grinding stone is sprayed with water, and the generated fibre suspension, the pulp, is stored, and whereby the pulp's drainability or freeness CF and a second quantity Q characterising the quality of the pulp are measured, the measured values CFx and Qx are compared with the set points CF0 and Q0 of the corresponding quantities, and the wood supply rate Vn or the wood supply pressure Fn and the peripheral speed Vp of the grinding stone are adjusted so that the sum (CFx - CF0)2 + (Qx - Q0)2 obtains its minimum value, whereby pressurised water sharpening of the grinding stone is initiated when the grinding stone reaches a certain degree of bluntness being defined e.g. as a certain value of the wood supply pressure Fn or the wood supply rate Vn or a variable depending on these, characterised in that this pressurised water sharpening is continued until the measured quality quantity Qx deviates from its set point Q0 by a given amount, the difference ΔQ, after which the pressurised water sharpening is discontinued, and the wood supply rate Vn or the wood supply pressure Fn and the grinding stone's peripheral speed Vp are adjusted so that the sum (CFx - CF0)2 + (Qx - Q0)2 obtains its minimum value.

2. A method according to claim 1, characterised in that the quantity Q is a measure of the pulp's tearing resistance, such as e.g. the tear index RI.

3. A method according to claim 1, characterised in that the quantity Q is a measure of the pulp's delamination strength.

4. A method according to claim 1, characterised in that the quantity Q is a measure of the pulp's bulk.

5. A method according to any previous claim 1 to 4, characterised in that the pressure of the pressurised water is increased during the pressurised water

sharpening.

6. A method according to any previous claim 1 to 4, characterised in that the wood supply rate Vn, the wood supply pressure Fn and the grinding stone's peripheral speed Vp are kept almost constant during the pressurised water sharpening.

7. A method according to any previous claim, characterised in that the pressurised water sharpening is initiated at a wood supply pressure where the hydraulic valve or valves are open at least 90 % during a given time, and that the pressurised water sharpening is discontinued when the measured quality quantity Qx deviates from its set point Q0 by a defined difference ΔQ.

8. A method according to any of the previous claims, characterised in that the control is made with the aid of a multi-variable control algorithm.

INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER

IPC7: D21B 1/18
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: D21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9749857 A1 (FORSMAN, TOM), 31 December 1997 (31.12.97), claims 1-4	1-8
A	WO 9302836 A1 (VALMET-TAMPELLA OY), 18 February 1993 (18.02.93), claim 1	1-8

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
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"P" document published prior to the international filing date but later than the priority date claimed
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"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

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INTERNATIONAL SEARCH REPORT
Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9749857 A1	31/12/97	FI 102975 B	00/00/00
		FI 962626 A	26/12/97
WO 9302836 A1	18/02/93	AU 2368592 A	02/03/93
		DE 4292499 T	09/06/94
		FI 88938 B,C	15/04/93
		FI 913803 A	10/02/93
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		GB 9402153 D	00/00/00
		JP 7500775 T	26/01/95
		SE 503135 C	01/04/96
		SE 9400424 A	09/02/94